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Campbell et al.

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(54) **MAST LIFT WITH SCREW DRIVE AND GAS STRUT**

(71) Applicant: **JLG Industries, Inc.**, McConnellsburg, PA (US)

(72) Inventors: **Geoffrey George Campbell**, Kensington (AU); **Jason James Watson**, Matraville (AU); **Mark Nathan Spaile**, Little Bay (AU)

(73) Assignee: **JLG INDUSTRIES, INC.**, McConnellsburg, PA (US)

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B66F 11/04 (2006.01)
E04G 1/22 (2006.01)

(52) **U.S. Cl.**
CPC ***B66F 11/04*** (2013.01); ***E04G 1/22*** (2013.01)

(58) **Field of Classification Search**
CPC B66F 11/04; B66F 11/046; E04G 1/22
See application file for complete search history.

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Primary Examiner — Colleen M Chavchavadze
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

A mast lift includes a base and a telescoping mast coupled with the base and extending upward from the base. The telescoping mast has a support section fixed to the base and a movable section movably connected and displaceable relative to the support section between a retracted position and an extended position. A top cap is secured to the movable section, and a platform is supported by the top cap and the movable section. A gas strut acts between the support section and the movable section and biases the movable section toward the extended position. A threaded driving rod is connected between the top cap and the base and extends through a fixed nut assembly.

7 Claims, 13 Drawing Sheets

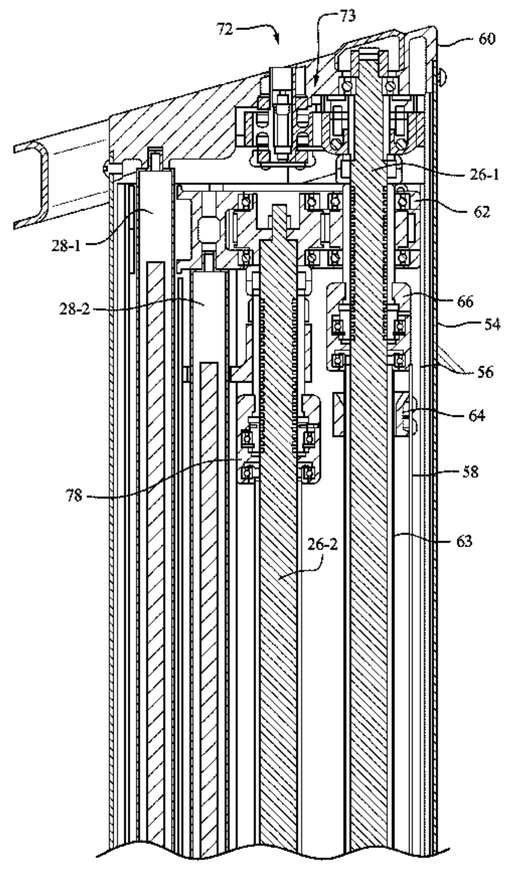

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Fig. 2

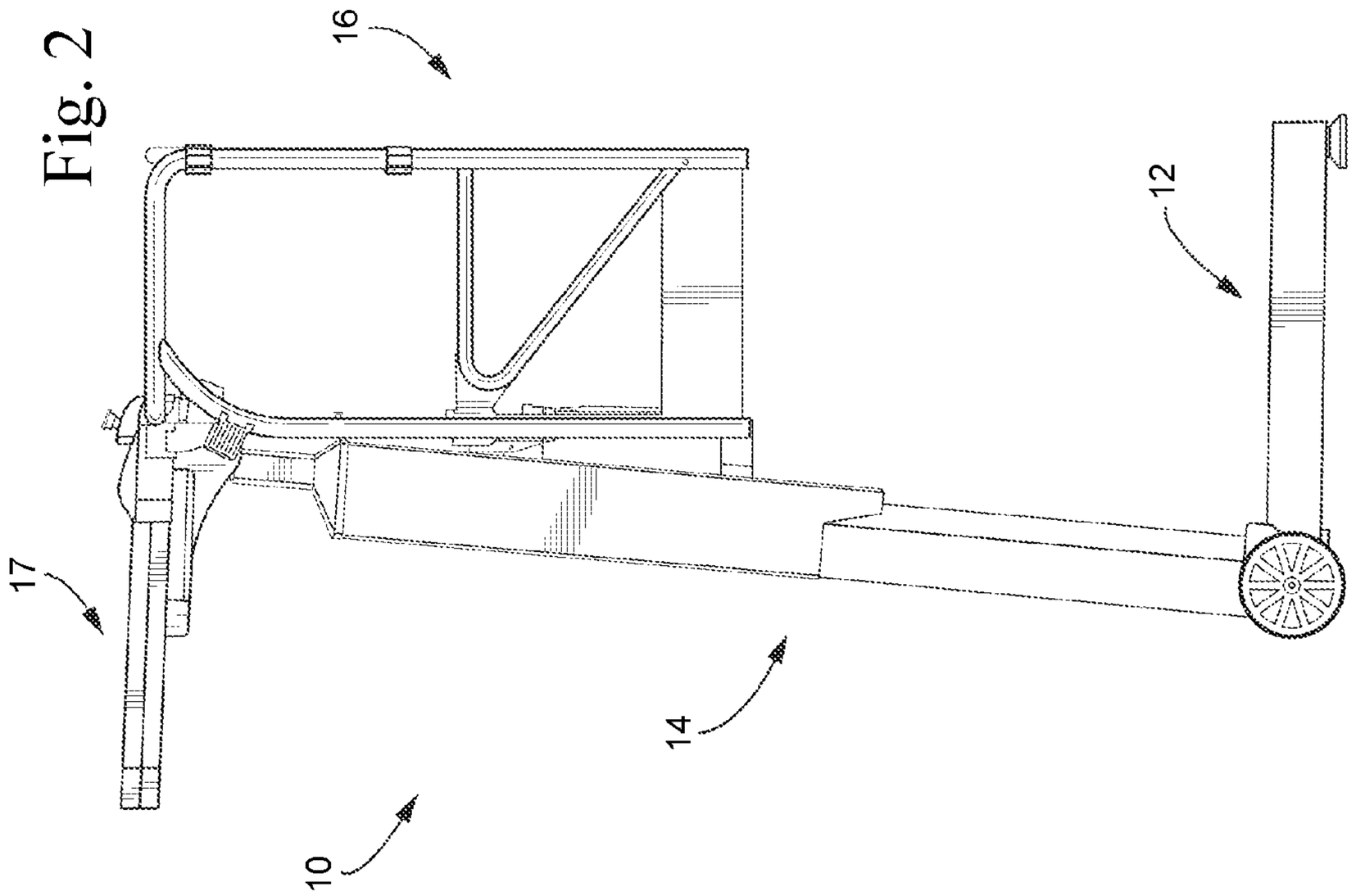
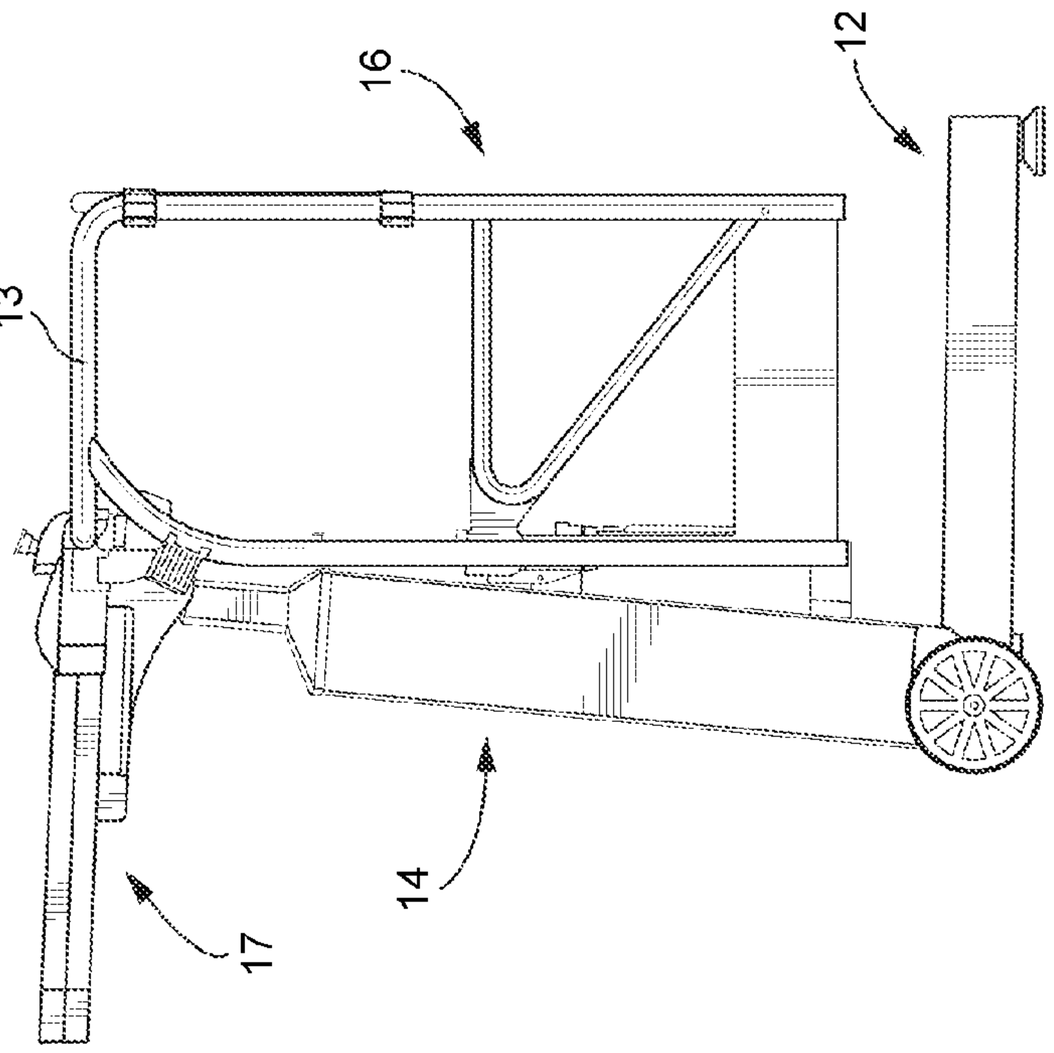


Fig. 1



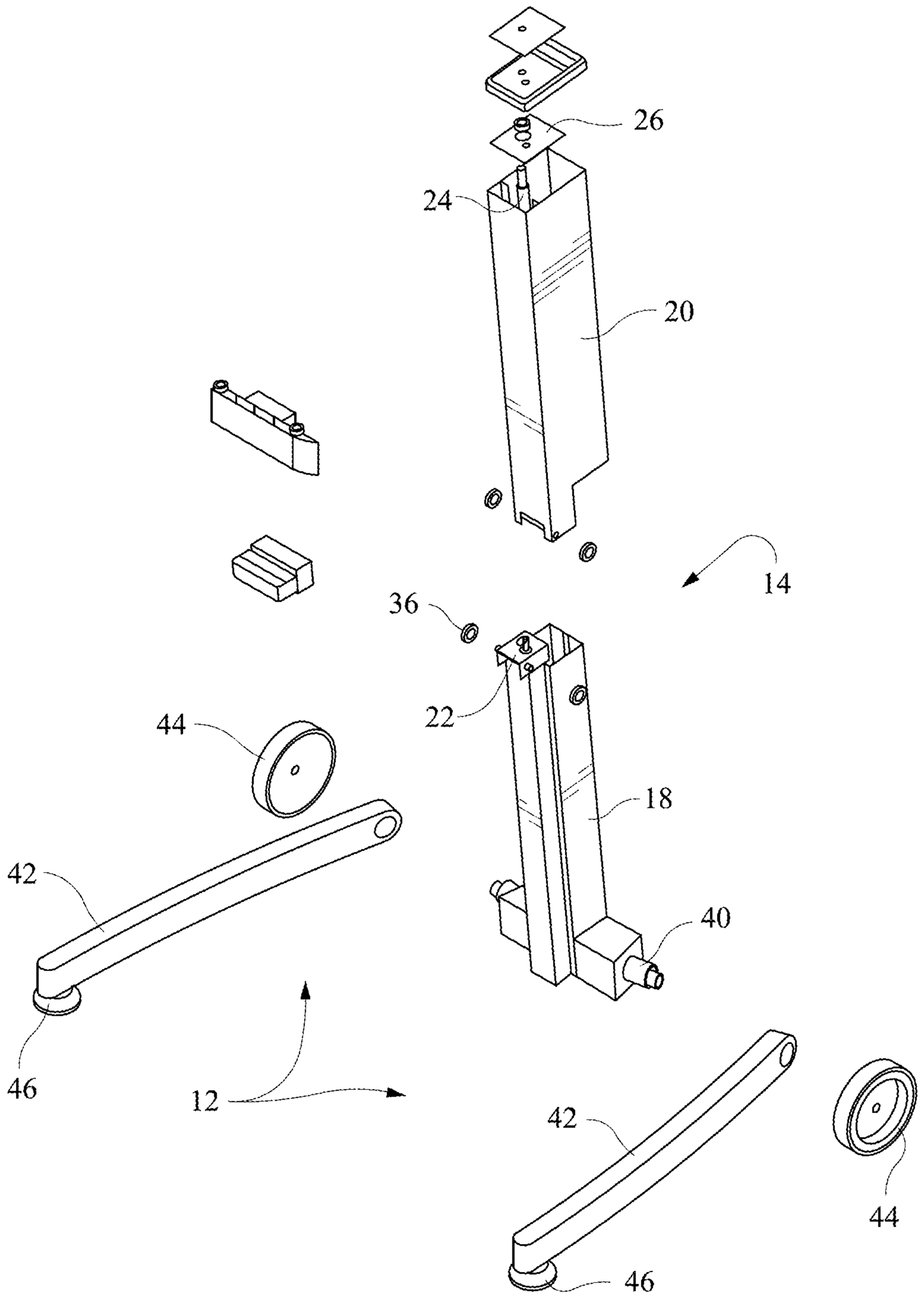


Fig. 3

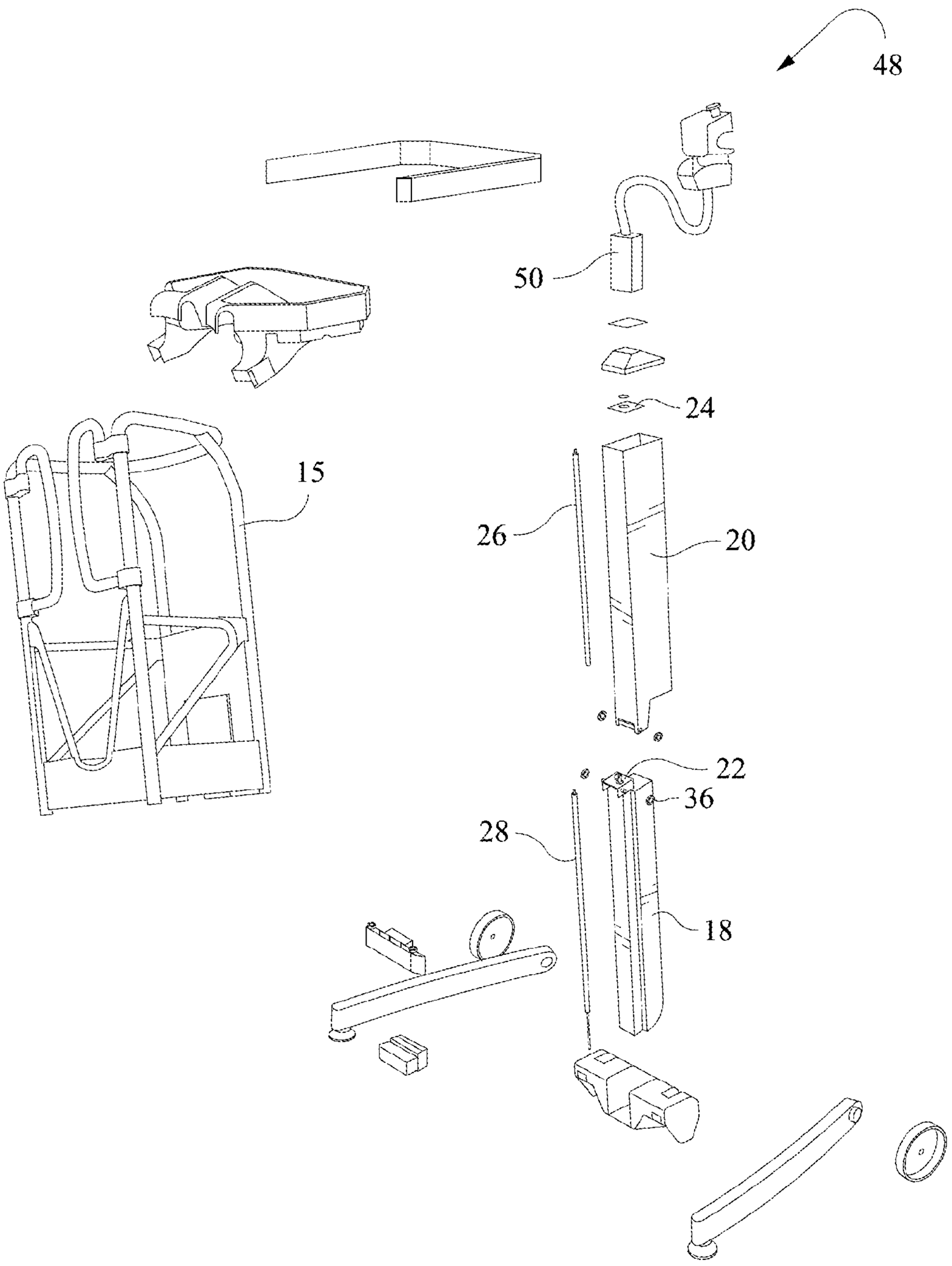


Fig. 4

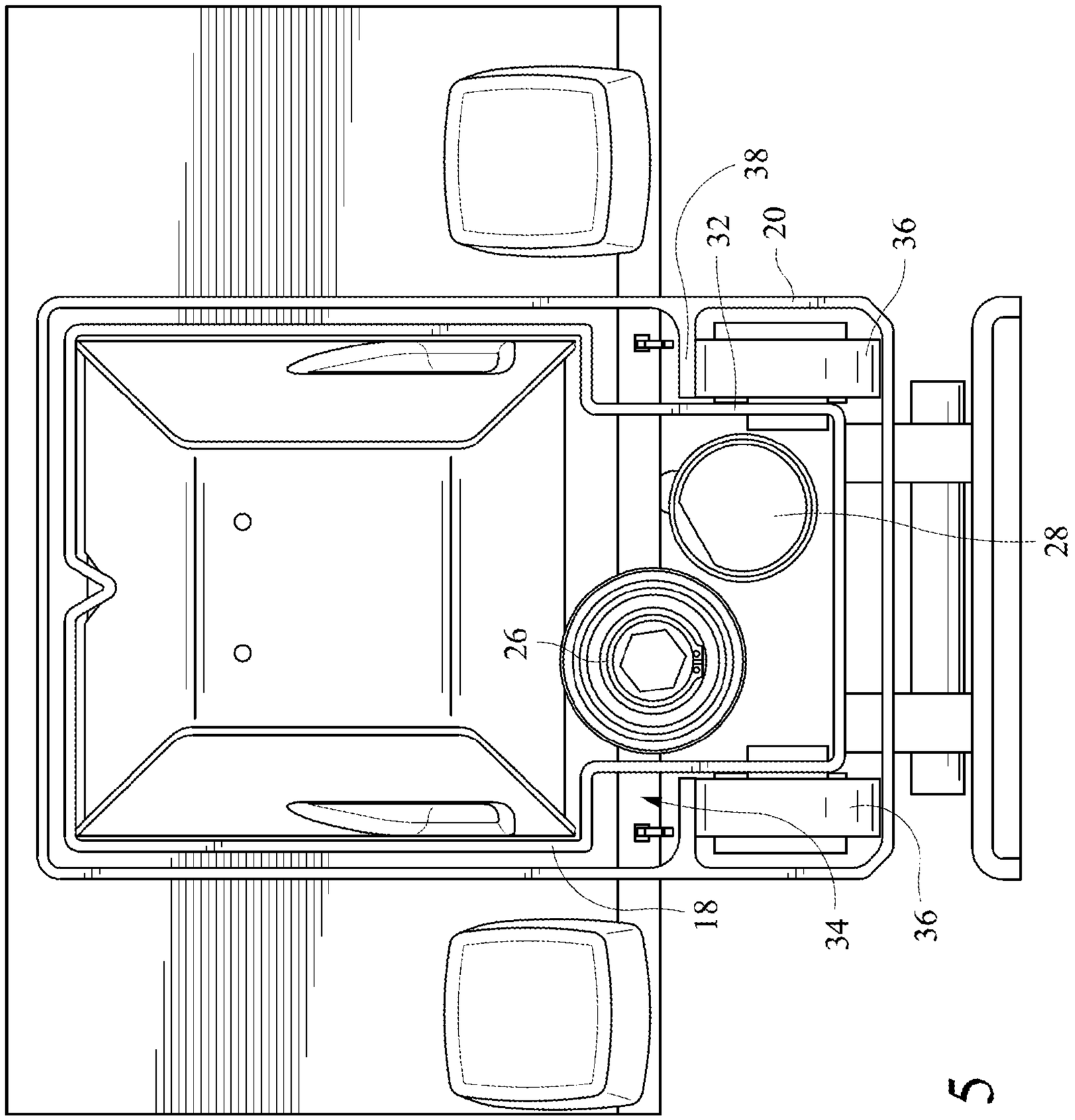


Fig. 5

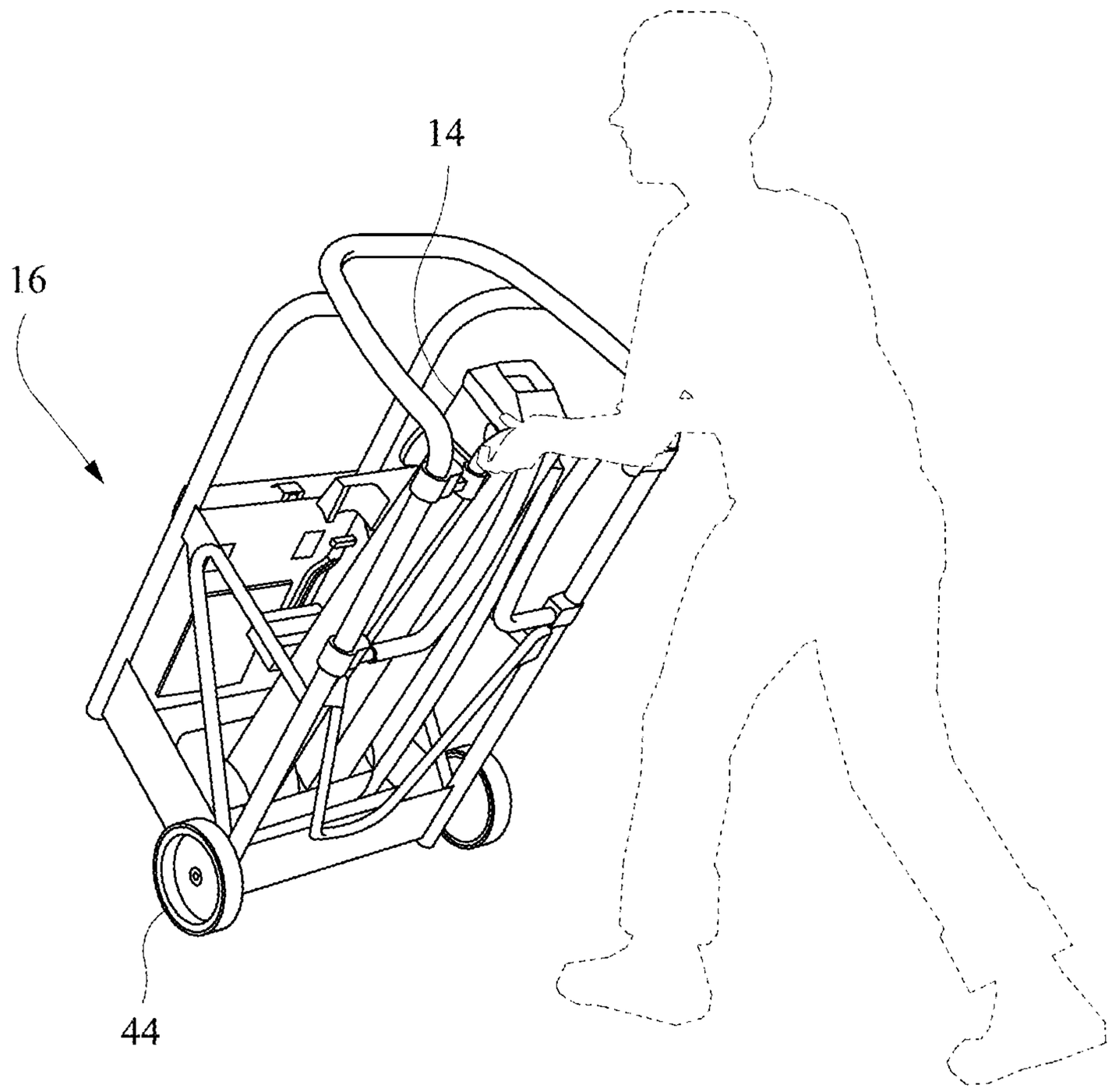


Fig. 6

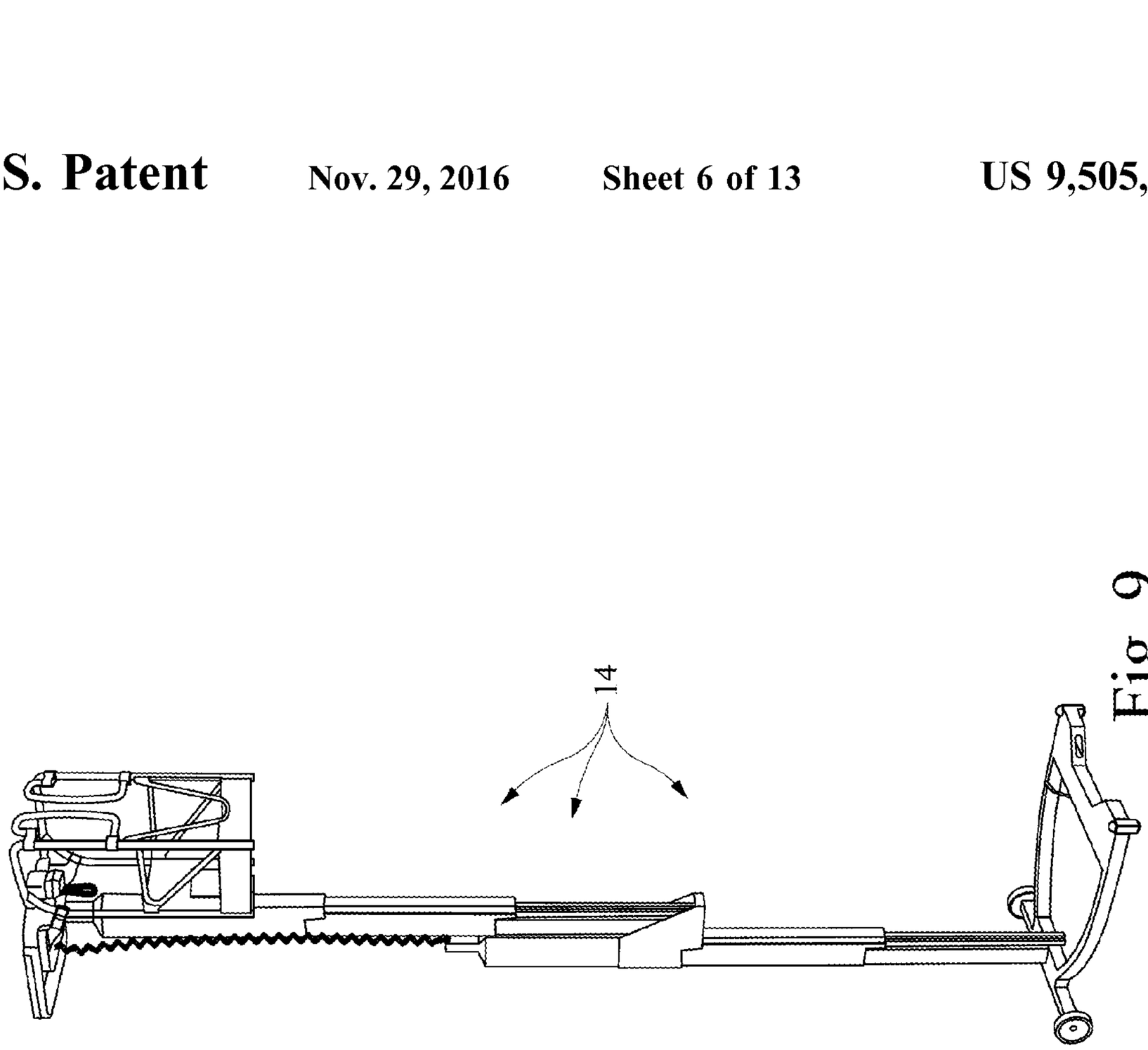


Fig. 9

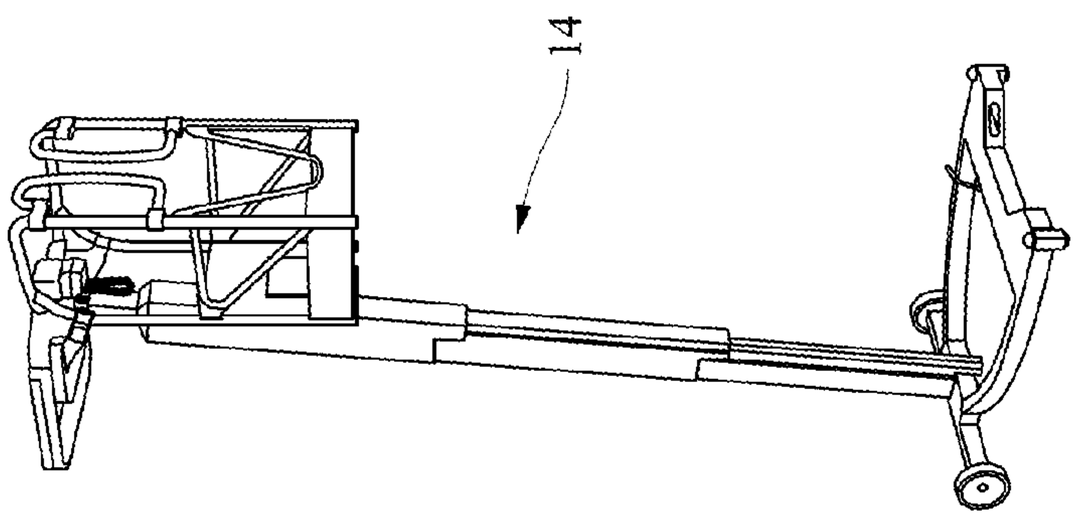


Fig. 8

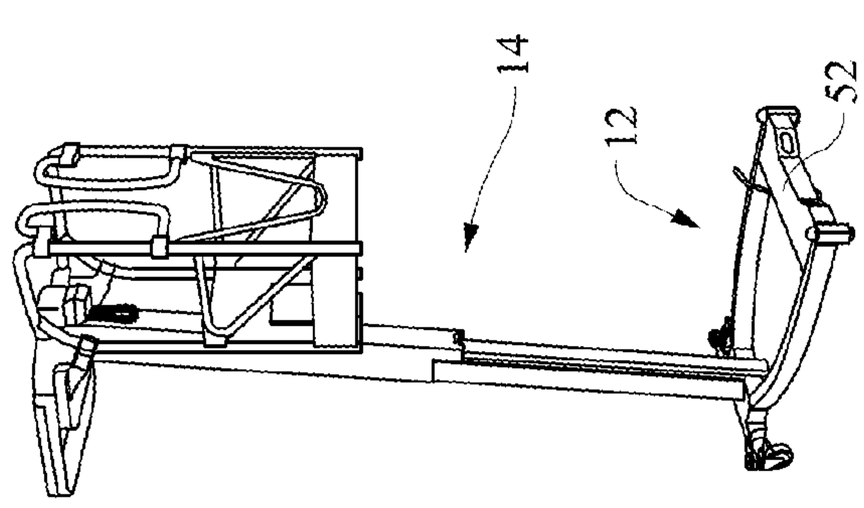


Fig. 7

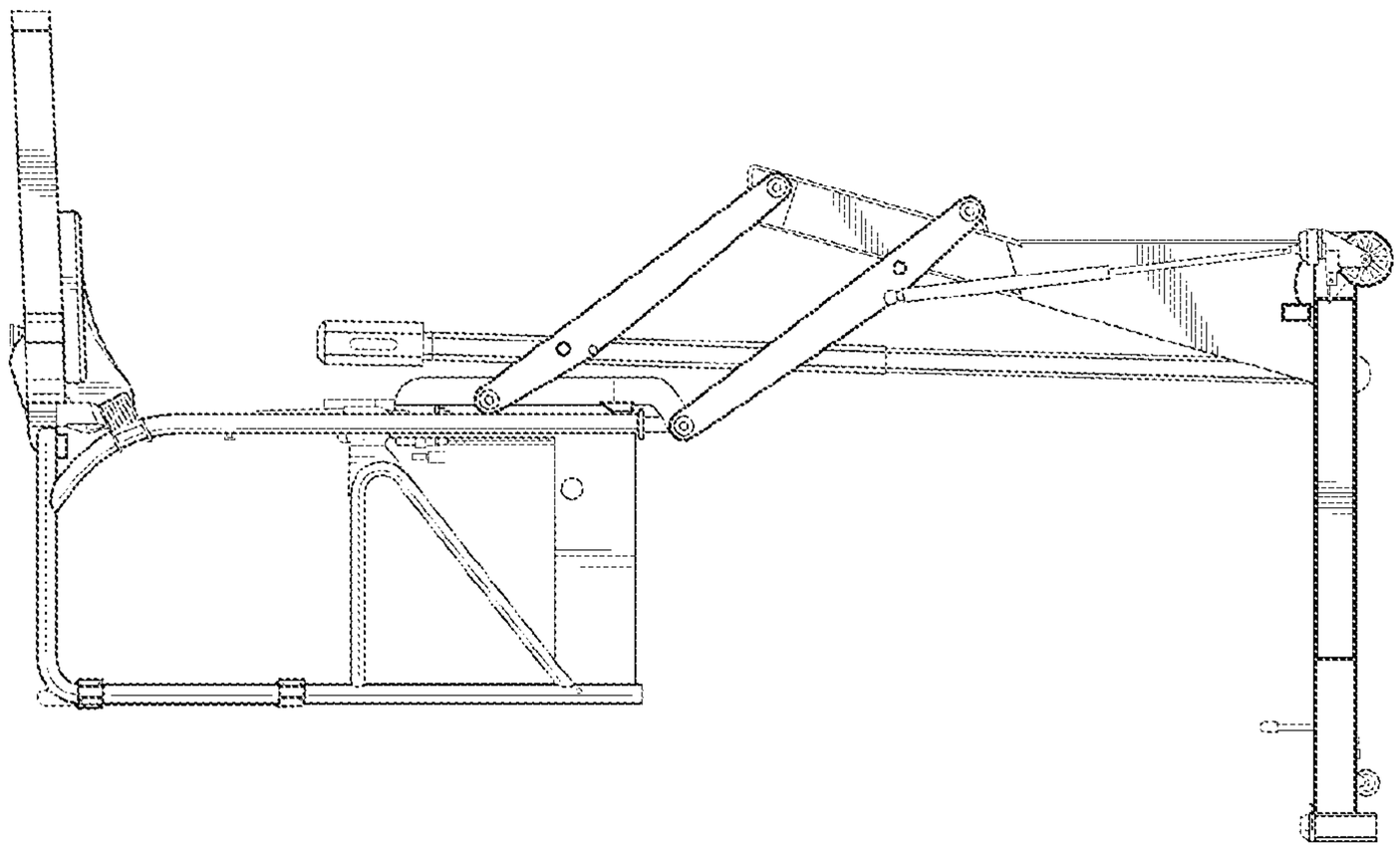


Fig. 12

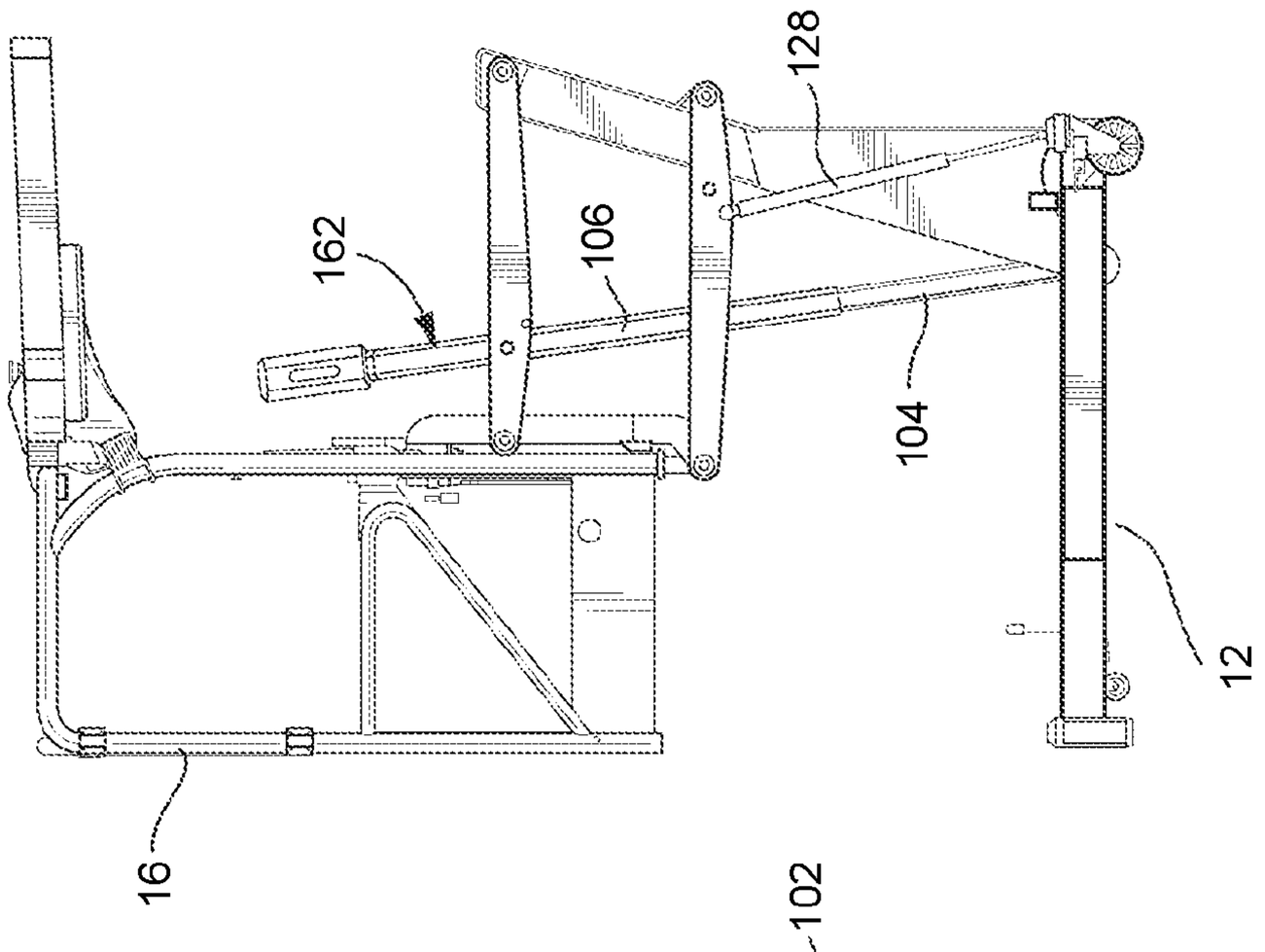


Fig. 11

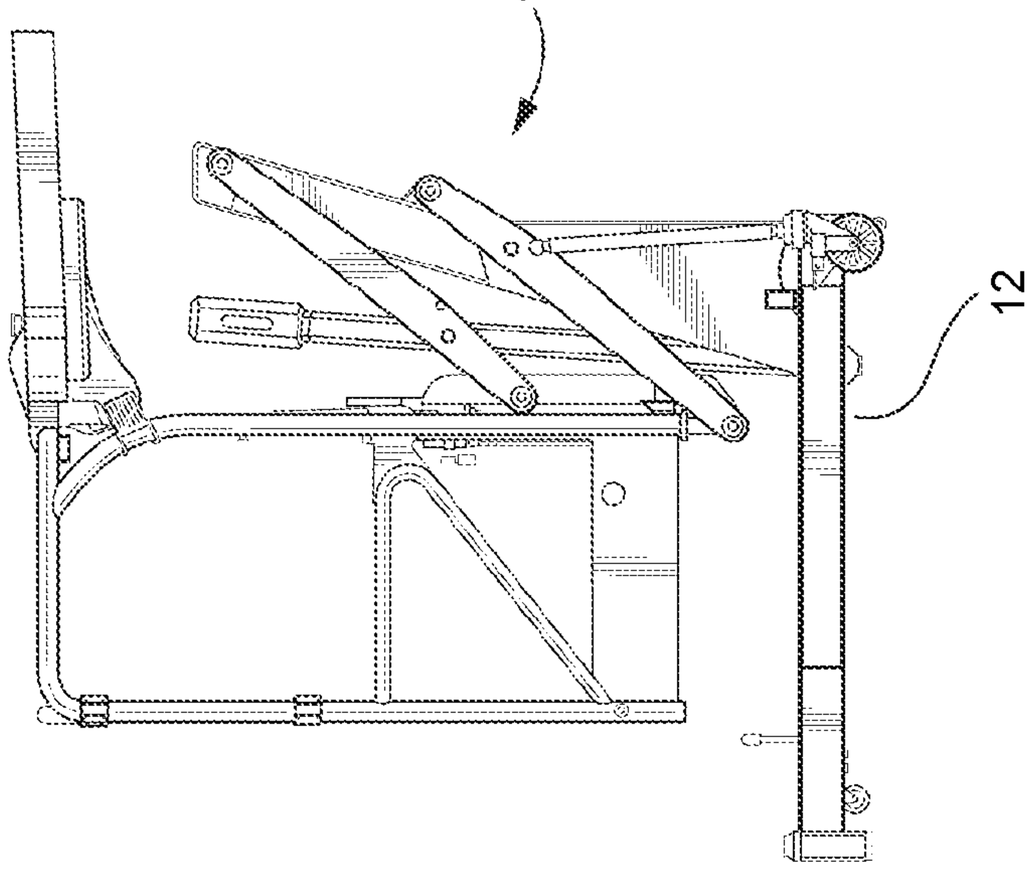


Fig. 10

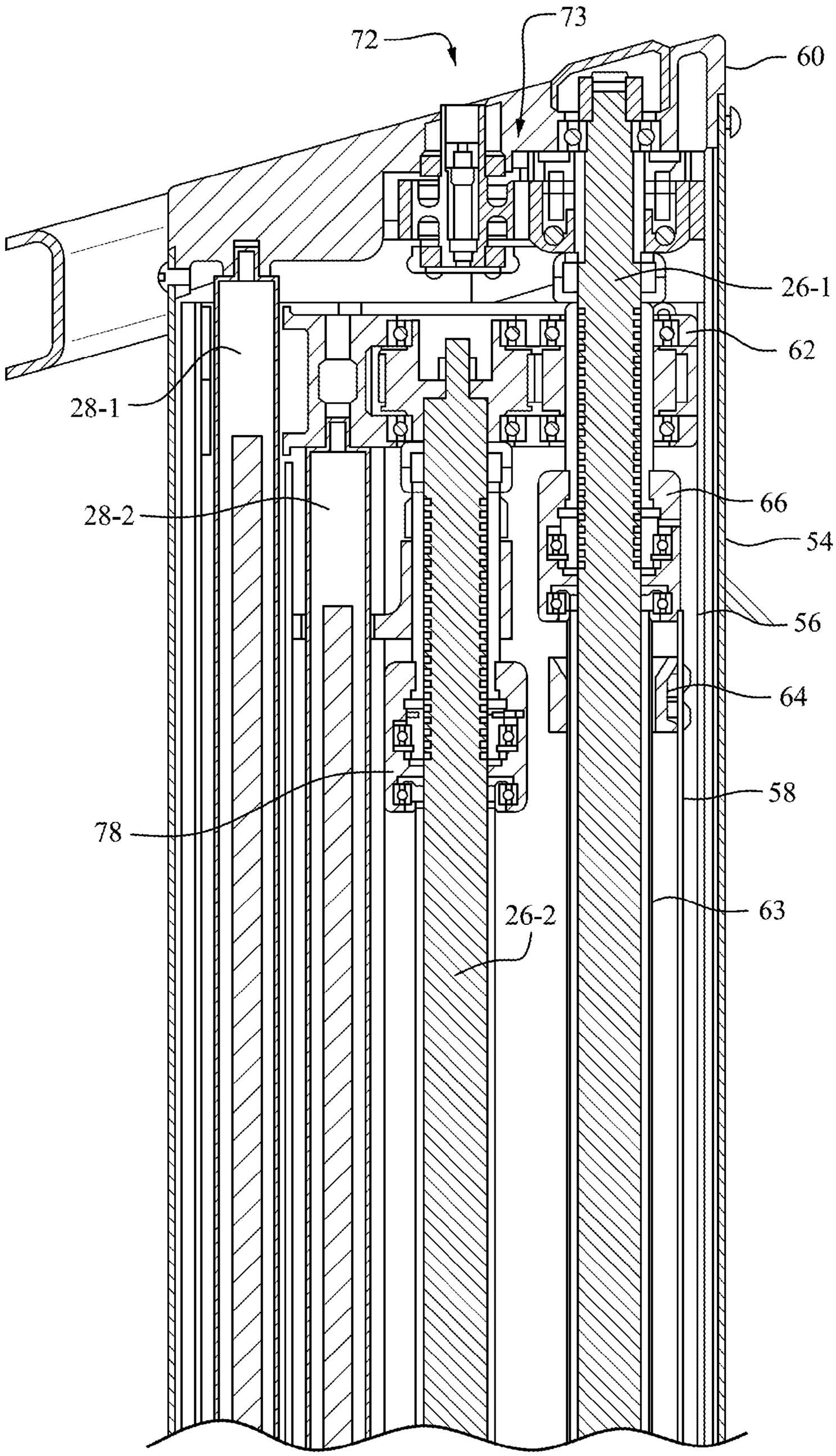


Fig. 13

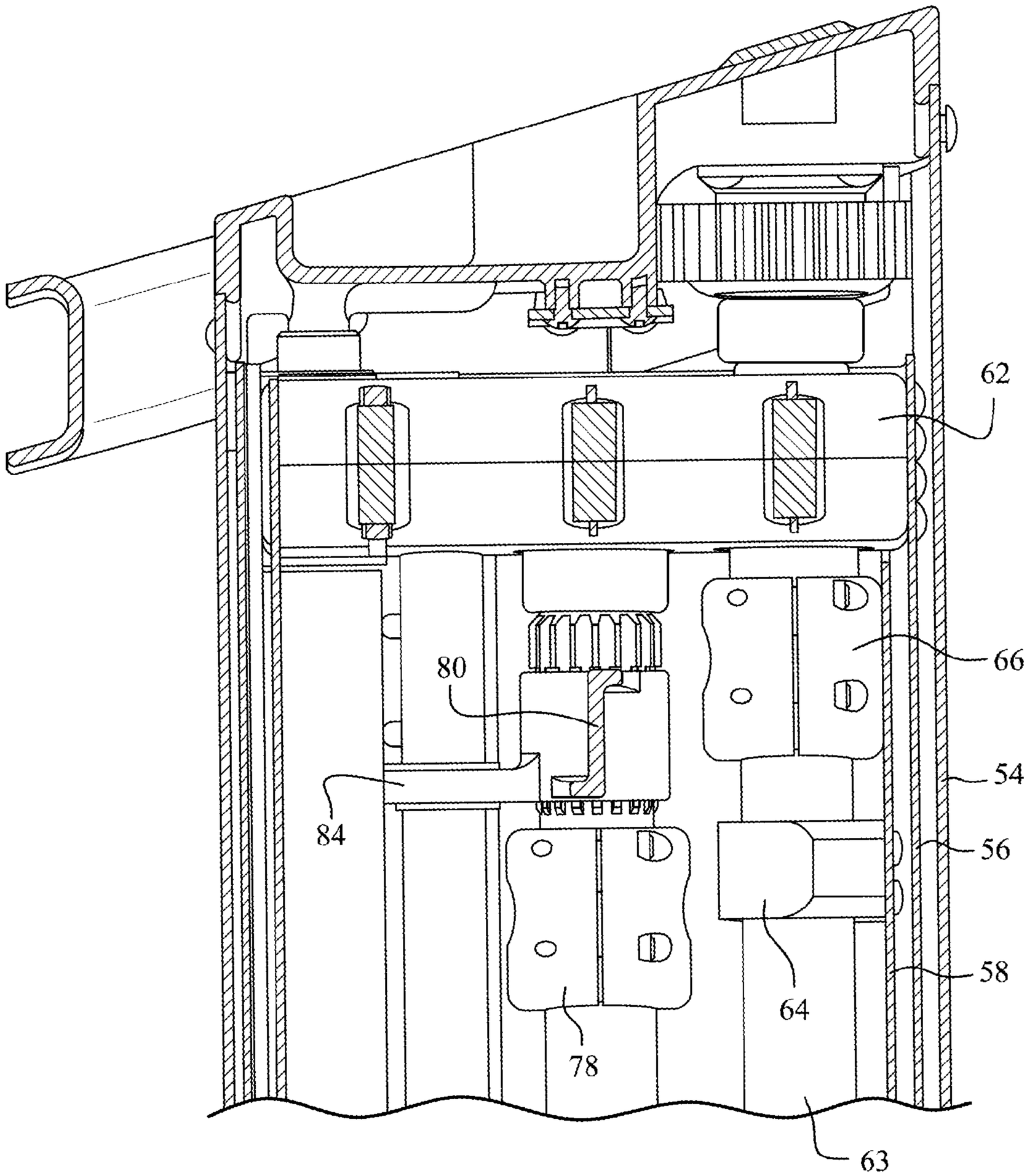


Fig. 14

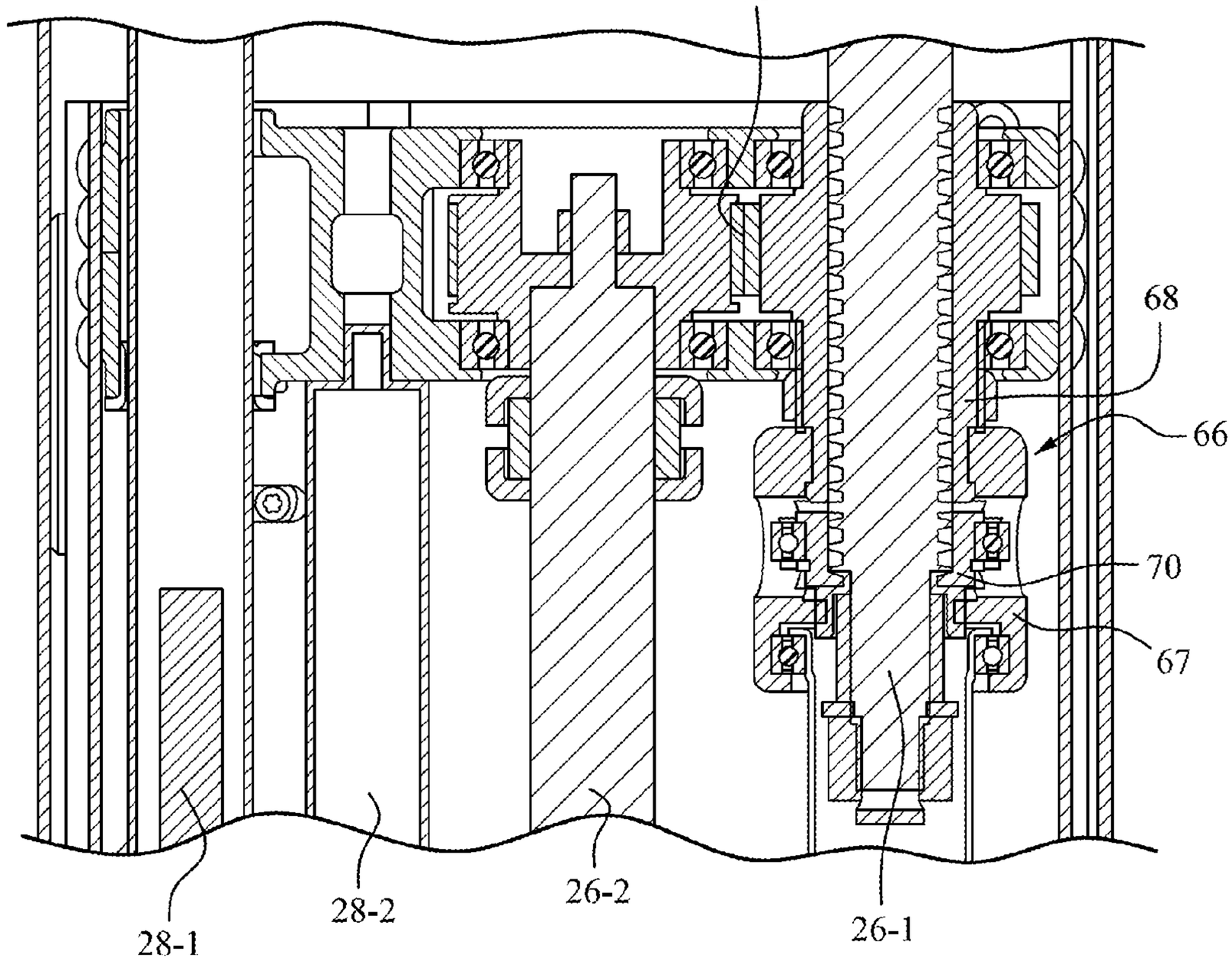


Fig. 15

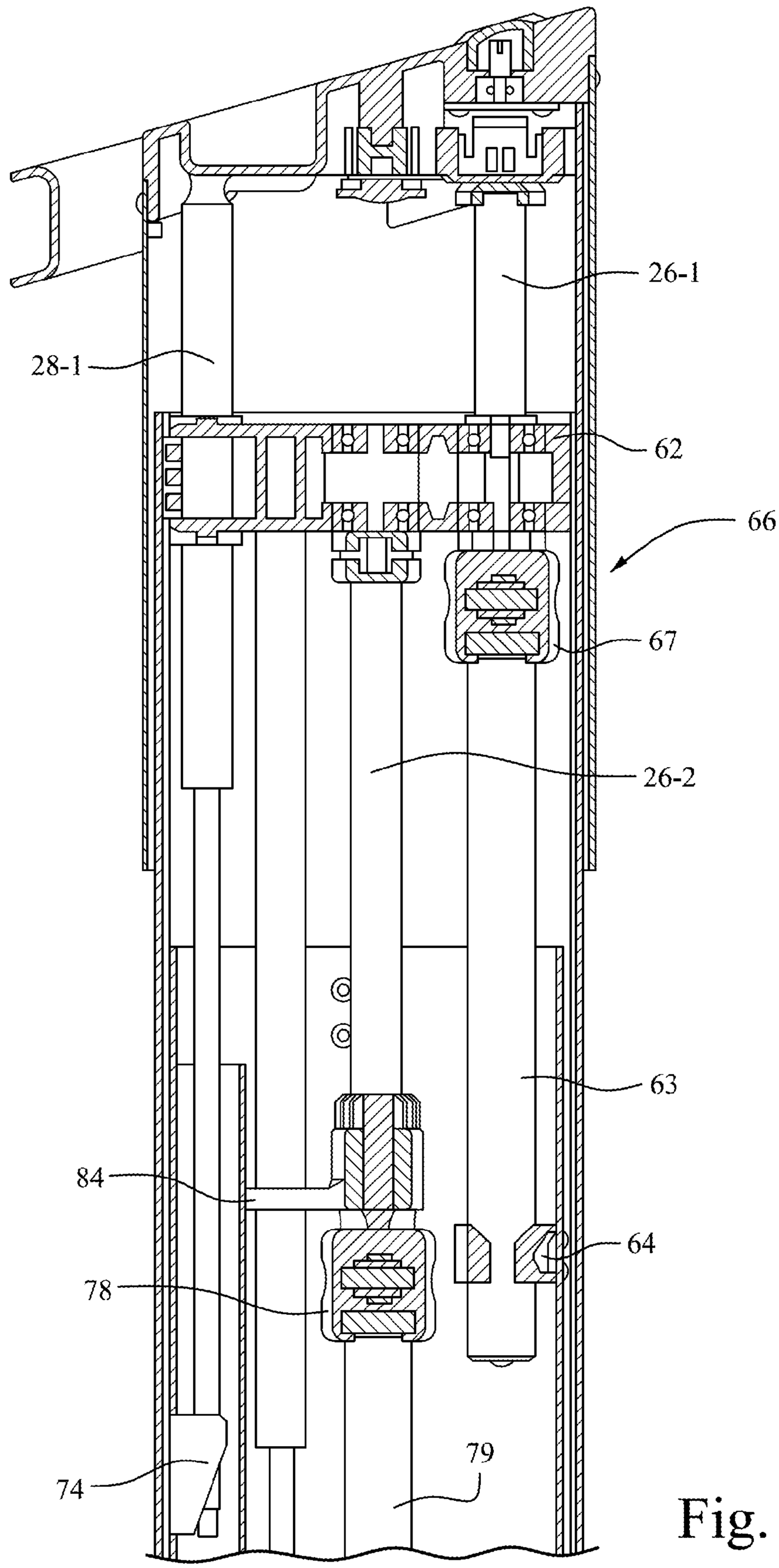


Fig. 16

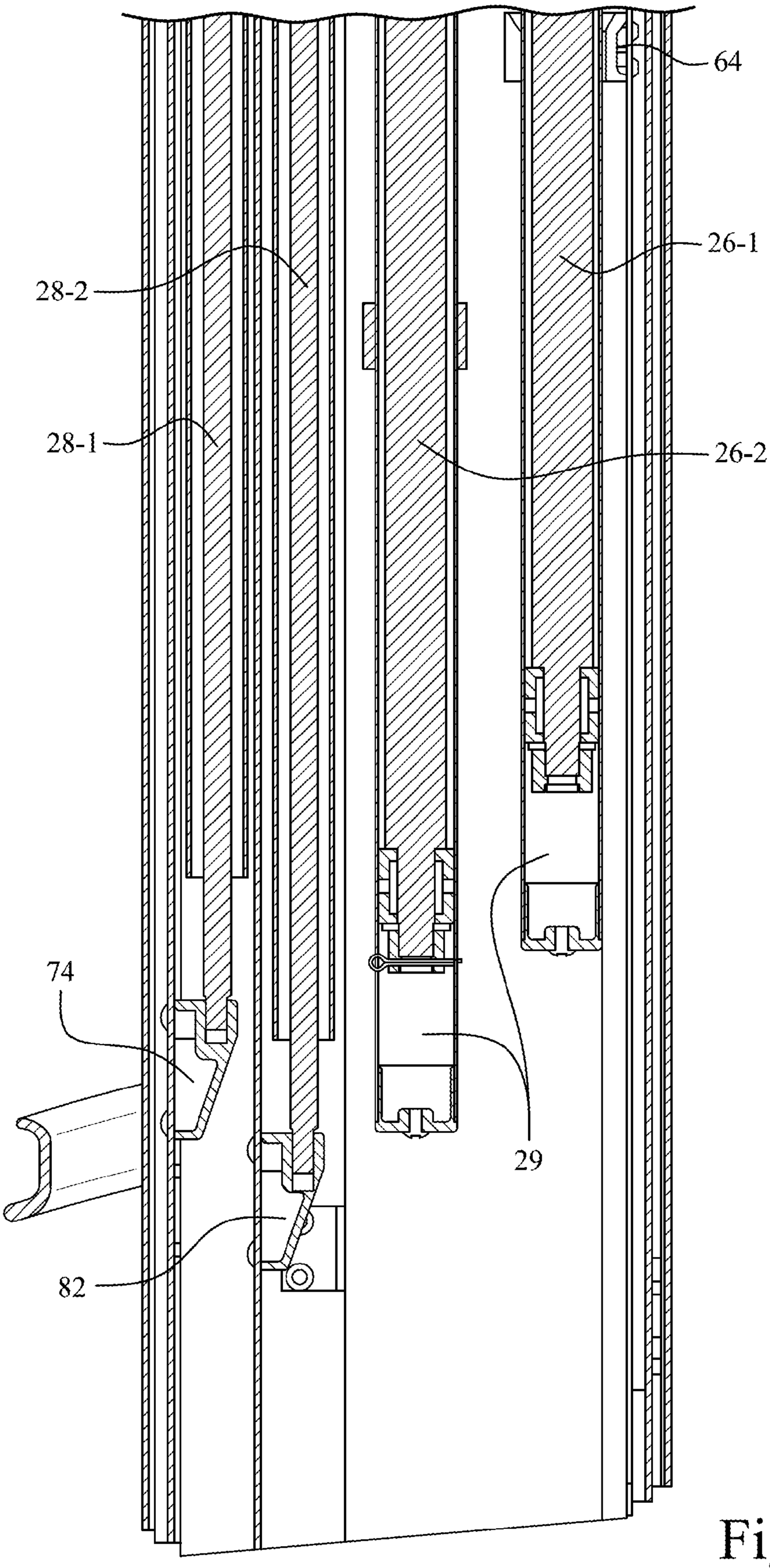


Fig. 17

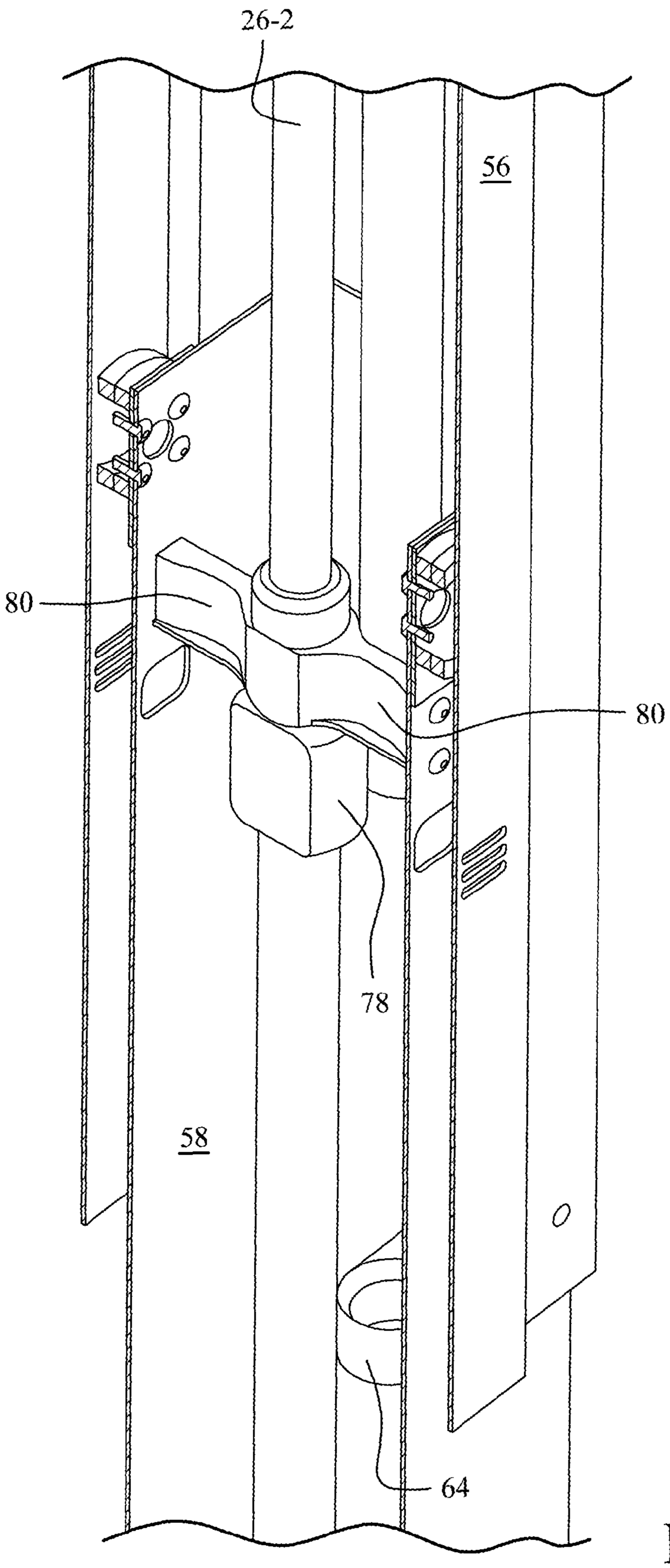


Fig. 18

MAST LIFT WITH SCREW DRIVE AND GAS STRUT

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part (CIP) of U.S. patent application Ser. No. 13/191,676, filed Jul. 27, 2011, pending, which claims the benefit of U.S. Provisional Patent Application No. 61/374,368, filed Aug. 17, 2010, the entire contents of each of which are hereby incorporated by reference in this application.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

(Not Applicable)

BACKGROUND OF THE INVENTION

The present invention relates to a personnel lift and, more particularly, to a portable lift machine including a work platform raised and lowered by a lifting system. The LiftPod® system by JLG Industries, Inc. has been described in U.S. patent application Ser. Nos. 10/594,666, 11/581,785, 12/190,217, 12/293,759, U.S. Pat. Nos. D570,071, 7,614,459, 7,762,532, and 7,766,750. See also www.LiftPod.com. The contents of the referenced documents and website are incorporated by reference.

The ladder concept is several thousand years old. Existing ladders, however, can be cumbersome and difficult to maneuver. Additionally, conventional ladders can be unstable particularly on uneven ground, and a work area is limited to the user's reach.

Ladder companies are reluctant to develop powered mechanical products. It would be desirable, however, to develop a personnel lift that achieves many of the advantages of a ladder, e.g., can be set up and used by a single operator, lightweight, etc., while providing for greater stability and a larger working area in a portable powered machine

Mast climbing platforms are known and typically include a mast that can be free-standing or supported by a wall or other support structure. However, existing mast climbers have minimum SWL loads of 1000 lbs and are not portable or operable by a single user due at least to their size. Vertical mast products and aerial work platforms include a moving platform and generally are also typically too large for portability and are very far from the many advantages provided by a ladder in terms of portability, low cost and ease of use.

To achieve portability, a light weight, reliable lift system mechanism is desirable to provide the functionality expected of a device which lifts personnel.

BRIEF SUMMARY OF THE INVENTION

A desirable feature of the LiftPod system is its low weight and portability. A single operator can assemble the unit. The portable construction enables the single operator to carry it up stairs, load the unit in a truck bed, etc. The system incorporates a full platform with rails around the operator for security. Lift power can be provided via a cordless drill or a dedicated power pack.

The invention embodies a personnel lift system that is smaller in construction than the original LiftPod® system.

The invention can serve as an alternative to step ladders (up to 1.8 m/6 ft.) and can incorporate extensions to achieve higher reach.

Gas struts may be provided to store energy in the lowered position and thereby reduce power requirements for the lift. The gas strut in combination with a screw thread (such as an acme screw) and cordless DC motor/battery can provide both the means to power and control the machine to lift and lower a person in the platform in a secure manner.

In an exemplary embodiment, a mast lift includes a base and a telescoping mast coupled with the base and extending upward from the base. The telescoping mast has a support section fixed to the base and a movable section movably connected to and displaceable relative to the support section between a retracted position and an extended position. A top cap is secured to the movable section, and a platform is supported by the top cap and the movable section. A gas strut acts between the support section and the movable section and biases the movable section toward the extended position. A threaded driving rod is connected between the top cap and the base and extends through a fixed nut assembly.

The gas strut may be secured to the base. The mast lift may additionally include a drive link coupled with the threaded driving rod that receives a rotary power source to rotate the threaded driving rod. The drive link may comprise a socket for receiving a complementary bit of a hand-held power drill. The fixed nut assembly may include a housing secured to the gas strut and a nut disposed in the housing, where the threaded driving rod may be threaded through the nut. The telescoping mast may additionally include a middle section cooperable with the support section and the movable section. In this context, the mast lift may further include a second gas strut and a second threaded driving rod that are configured to displace the middle section relative to the support section.

In another exemplary embodiment, a mast lift includes a base and a telescoping mast coupled with the base and extending upward from the base. The telescoping mast includes a support section fixed to the base, a middle section displaceable relative to the support section, and a top section displaceable relative to the support section and the middle section. A top cap is secured to the top section, and a platform supported by the top cap and the top section. A gear box is secured to the middle section. A first gas strut is secured at one end to the middle section and acts between the middle section and the top section and biases the top section toward an extended position. A first threaded driving rod is connected between the top cap and the middle section and extends through a first fixed nut assembly. A second gas strut may be secured between the gear box and the support section, and a second threaded driving rod may be connected between the gear box and the base and extending through a second fixed nut assembly. The second threaded driving rod may be fixed to the second gas strut. The gear box may include a power transfer belt connected between the first threaded driving rod and the second threaded driving rod, where the first threaded driving rod is configured such that when the first threaded driving rod reaches a maximum extended position, the rotary power is transferred to the second threaded driving rod by the power transfer belt.

In yet another exemplary embodiment, a multi-section mast lift includes a base; a telescoping mast supported on the base, the telescoping mast including a support section secured to the base, at least one middle section cooperable with the support section and displaceable relative to the support section between a retracted position and an extended position, and a top section cooperable with a topmost one of

the at least one middle section and displaceable relative to the topmost one of the least one middle section between a retracted position and an extended position; a top cap secured to the top section; a platform supported by the top cap and the top section; a gear box secured to the at least one middle section; and a lifting assembly for displacing the top section and the at least one middle section between the retracted and extended positions, the lifting assembly including a threaded driving rod and a gas strut for each of the top section and the at least one middle section, wherein the threaded driving rods are driven by rotating a single drive link cooperable with the lifting assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be described in detail with reference to the accompanying drawings, in which:

FIG. **1** is a side view of the assembled mast lift with the platform in a lowered position;

FIG. **2** is a side view of the assembled mast lift with the platform in a raised position;

FIGS. **3** and **4** are exploded views showing parts of the mast lift;

FIG. **5** is a top plan view looking into the telescoping mast;

FIG. **6** shows a transport configuration of the mast lift;

FIGS. **7-9** show alternative constructions utilizing modified mast components;

FIGS. **10-12** show an alternative mast lift embodiment using a double linkage parallelogram assembly; and

FIGS. **13-18** are sectional views of the lift mechanism operating components.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIGS. **1-4**, a mast lift **10** includes a base **12** and a telescoping mast **14** coupled with the base **12** and extending upward from the base **12**. A platform **16** is secured to a movable section of the telescoping mast **14**. A lifting assembly is connected between the base **12** and the platform **16** and moves the platform **16** between a lowered position (FIG. **1**) and a raised position (FIG. **2**). The platform **16** includes a safety rail **13** and a gate **15**. Additionally, an accessory tray **17** may be connected to the platform **16**. Other or alternative accessory items may be attached. For example, the design can be customized with specific accessories for a specific user purpose, i.e., the machine may designed such that it can accommodate a number of accessories specific to user requirements, including tool trays, buckets, drawers, paint trays, cleaning, and other accessories. These accessories may be attached to the mast, base or platform.

The telescoping mast **14** is provided with a support section **18** fixed to the base **12** and a movable section **20** movably connected to and displaceable relative to the support section **18** between a retracted position (lowered position shown in FIG. **1**) and an extended position (raised position shown in FIG. **2**). The platform **16** is secured to the movable section **20** of the mast **14**.

With reference to FIGS. **3** and **4**, a first driving plate **22** is secured to the support section **18**, and a second driving plate **24** is secured to the movable section **20**. A threaded driving rod **26** (such as an acme screw) is connected between the first driving plate **22** and the second driving plate **24**. That is, the threaded driving rod **26** is fixed to one of the first and second driving plates **22**, **24** and is movably threaded in an opening in the other of the first and second driving plates **22**, **24**. In a preferred arrangement, the first driving plate **22** secured to the support section **18** includes the threaded opening or a bolt opening through which the threaded driving rod is movable by rotating the threaded driving rod **26**. In this preferred arrangement, the rod **26** is fixed to the second driving plate **24** in the movable section **20** of the telescoping mast **14**.

Those of ordinary skill in the art will appreciate alternative configurations for the drive construction, and the invention is not necessarily meant to be limited to the described and illustrated examples. For example, an alternative configuration could fix the threaded rod rotationally and drive the nut/threaded hole. In this context, the thread can be fixed to the lower section of the mast, whilst the nut is rotated and drives the machine up. The thread could similarly be fixed to the top section whilst driving the nut. To drive the nut, it may simply be a hollow tube with the drive shaft connected on top for matching to the drill/power pack.

A gas strut **28** acts between the support section **18** and the movable section **20** and is configured to bias the movable section **20** toward the extended position (platform raised position—FIG. **2**). The gas strut **28** stores energy in the lowered position to thereby reduce the power requirements for the lift.

With reference to FIGS. **3-5**, in a preferred construction, an inside perimeter of the movable section **20** is larger than an outside perimeter of the support section **18**, and the movable section **20** is disposed over the support section **18**. As shown in FIG. **5**, the outside perimeter of the support section **18** may be substantially T-shaped, including a head section **30** and a leg section **32**. In this arrangement, the threaded driving rod **26** and the gas strut **28** are disposed generally in the leg section **32** of the T-shape. The T-shaped perimeter of the support section **18** defines respective bearing spaces **34** on opposite sides of the leg section **32**. Bearings **36** are secured to each side of the support section **18** in the bearing spaces **34**, respectively. The movable section **20** may be provided with a bearing guide **38** extending inward into each of the bearing spaces **34** on opposite sides of the leg section **32** of the support section **18**. The bearings **36** are positioned between the bearing guides **38** and an outer wall of the movable section **20** as shown in FIG. **5**.

With reference to FIG. **3**, the base includes an axle **40** to which the support section **18** is connected. A pair of base legs **42** are secured to the axle **40** on opposite sides of the support section **18**. The axle **40** extends through openings in the base legs **42**. A pair of wheels **44** are respectively secured to the axle **40** on opposite sides of the support member **18** and through the base legs **42**. Supporting feet **46** are disposed on ends of the base legs **42** opposite from the axle **40**.

As shown in FIG. **4**, the mast lift may additionally include a power pack **48** that is coupled with the threaded driving rod **26**. The power pack includes a rotatable socket assembly **50** fixed at one end to the threaded driving rod **26** and is powered by a motor/gearbox assembly located inside the power pack **50**. Alternatively, a user can power the device using a rotary drive source such as a hand-held power drill or the like by engaging the drill or a socket to the top of the drive shaft **26**.

In use, with the mast lift **10** in a lowered position (FIG. **1**), an operator can enter the platform **16** via the gate **15**. The operator engages a hand-held power drill with the power pack **48** to drive the threaded driving rod **26**. As the rod **26** is rotated, the rod **26** is displaced relative to the first driving

plate **22** secured to the support section **18** of the telescoping mast **14**. Since the opposite end of the rod **26** is fixed to the movable section **20** of the mast **14** via the second driving plate **24**, the movable section **20** moves with the driving rod **26** and telescopes over the support section **18** toward the raised position (FIG. **2**). The gas strut **28** assists in lifting the platform to thereby reduce power requirements for the lift. The platform **16** can be stopped in any position between the lowered position (FIG. **1**) and the raised position (FIG. **2**). Safeguards are provided to alert the operator when the platform has reached the maximum raised position. To lower the platform, the operation is reversed by reversing rotation of the threaded driving rod **26**. The weight of the platform **16** and the operator is sufficient to contract the gas strut **28** without impeding the operator's ability to efficiently lower the platform **16**.

The mast lift **10** is easily transported by a single user. For additional portability, the wheels **44** can be removed and placed onto the platform as shown in FIG. **6**. The mast/base may also collapse and fit into the platform. With the wheels on the platform and the mast in the platform, the machine is even more transportable and can be used to cart tools etc. In addition, the mast lift may be provided with a self-propel attachment including powered wheels attachable adjacent a front end of the base **12**. The self-propel attachment may be engaged and controlled by a user on the platform **16**.

The maximum reach of the lift can be extended through the use of a longer support section **18** and movable section **20**. Alternatively or additionally, the mast **14** may include one or more additional sections cooperable with the support section **18** and movable section **20**. For example, see FIGS. **7-9** showing 6 ft, 8 ft and 14 ft versions, respectively, using modified mast sections. In some arrangements, the base **12** may also be modified to accommodate added support requirements. The 6 ft version is an extended version of the mast and drive used on the 4 ft version, but the bottom of the lower mast is hollow and matches to the square base stump. The 6 ft version thus does not have the "T" as described for the 4 ft, but is a hollow mast end. Additionally, the base **12** includes a cross member **52** connecting the legs of the base **12** as shown in FIG. **7**. The 8 ft and 14 ft versions utilize a three-stage telescopic mast, which includes a telescopic acme drive.

FIGS. **13-18** are sectional views of the lift mechanism operating components. The assembly shown in FIGS. **13-18** corresponds to a three-section lift. The mast lift of course may include two sections or more than three sections, and the invention is not meant to be limited to the described exemplary application.

In the exemplary three-section lift, the lift mechanism includes a first threaded driving rod **26-1** acting between an outer section **54** and a middle section **56** and a second threaded driving rod **26-2** acting between the middle section **56** and the support (inner) section **58**. The assembly also includes a first gas strut **28-1** cooperating with the first threaded driving rod **26-1** and a second gas strut **28-2** cooperating with the second threaded driving rod **26-2**. Cylinders **29** house the driving rods when the mast is in a retracted position. The cylinders **29** keep the rods from hitting other objects within the mast when retracting, and they also house grease to keep the rods lubricated.

A top cap **60** is secured, e.g., bolted, to the outer section **54** and supports the platform **16** and operator. A gear box **62** is secured to the middle section **56** via a bolted connection or the like. The first threaded driving rod **26-1** is fixed or anchored to the middle section **56** within the gearbox **62**. A guide tube **63** surrounds the first threaded driving rod **26-1** and is supported via a guide **64** (clearance fit). The first threaded driving rod **26-1** extends through a corresponding first fixed nut assembly **66**. The nut assembly **66** preferably includes a nut housing **67**, a primary nut **68** and a safety nut **70**. As the first threaded driving rod **26-1** is rotated in the fixed nut **68**, the threaded driving rod **26-1** is displaced relative to the nut **68** (depending on the direction of rotation). The safety nut **70** acts as a back-up in the event that the primary nut **68** fails.

A drive link **72** receives a rotary power source such as a hand-held power drill or the like to rotate the threaded driving rod **26-1** through a set of gears **73**. In a preferred arrangement, the drive link **72** is a socket for receiving a complementary bit of the hand-held power drill.

The first gas strut **28-1** is anchored to the middle section **56** via a suitable connector **74** (see FIGS. **16-17**). As discussed previously, the gas strut **28-1** is biased to assist the first threaded driving rod **26-1** to lift or extend the outer section **54** relative to the middle section **56**.

With reference to FIG. **15**, the gear box **62** includes a power transfer belt **76** connected between the first threaded driving rod **26-1** and the second threaded driving rod **26-2**. When the friction between the primary nut **68** and the first threaded driving rod **26-1** is greater than the friction between the primary nut of a second fixed nut assembly **78** (described below) and the second threaded driving rod **26-2**, power is transferred to the second threaded driving rod **26-2** by the drive belt **76**. This takes place according to the path of least resistance, although it is typical that one section will fully extend or retract before power is transferred to the other driving rod. The extension or retraction of the mast sections is not timed (i.e., can be random) due to the system relying on the path of least resistance.

The second threaded driving rod **26-2** is connected between the gear box **62** and the support section **58**. A guide tube **79** surrounds the second threaded driving rod **26-2**. As noted, the support section **58** is secured with the base, and the second threaded driving rod **26-2** is effectively anchored to the base through the support section **58**. That is, the load is transferred from the second threaded driving rod **26-2** to the second fixed nut assembly **78**, from the second fixed nut assembly **78** to the support section **58** via a bolted connection **80** (see FIG. **18**), and from the support section **58** to the base. The second gas strut **28-2** is similarly secured between the gear box **62** and the base via the support section **58** and a connector **82**. The second threaded driving rod **26-2** extends through the second fixed nut assembly **78**. The second fixed nut assembly **78** is constructed generally corresponding to the first fixed nut assembly **66**. An arm and guide **84** is connected with the second gas strut **28-2** and acts as a guide for the gas strut **28-2**. The arm and guide **80** prevents the gas strut **28-2** from excessive bending and buckling.

In use, in a preferred embodiment, when the outer section **54** is extended, the first threaded driving rod **26-1** and the first gas strut **28-1** act in concert in an upward direction on the top cap **60**. As noted, the top cap **60** is bolted to the outer section **54**, which supports the platform **16** (and the operator). An opposing force is supported by the gear box **62** and is transferred to the middle section **56** via suitable connections (e.g., bolted connections). The middle section **56** thus acts as a support section as the outer section **54** is being extended.

After the outer section **54** has been raised/extended to a maximum position or when the friction between the first threaded driving rod **26-1** and the primary nut **68** exceeds the corresponding friction at the second threaded driving rod

26-2, the rotary power by the drive link **72** is transferred to the second threaded driving rod **26-2** by the power transfer belt **76**. The second gas strut **28-2** and the second threaded driving rod **26-2** act on the gear box housing **62** to extend/elevate the middle section **56**. The reaction forces are placed on the support section **58** and then are transferred to the ground via the machine base. At this point, the middle section **56** is the extending section and the support section **58** provides support for the lifting components acting on the middle section **56**.

FIGS. **10-12** show an alternative embodiment of the mast lift. Instead of a telescoping mast, the lifting assembly includes a double linkage parallelogram assembly **102**. In this embodiment, the threaded driving rod **126** includes a base rod **104** coupled to the base **12** and a moving rod **106** coupled to a linkage of the double linkage parallelogram assembly **102**. The moving rod **106** is linearly displaceable relative to the base rod **104** by relative rotation between the base rod **104** and the moving rod **106**. The gas strut **128** is connected between the base **12** and a linkage of the double linkage parallelogram assembly **102** as shown.

In use, after entering the platform **16**, an operator engages the threaded driving rod **126** with a hand-held power drill. As the rod is rotated, the moving rod **106** is displaced linearly relative to the base rod **104**, which causes the double linkage parallelogram assembly **102** to extend from the position shown in FIG. **10** toward the positions shown in FIGS. **11** and **12**. The gas strut **128** facilitates lifting the platform **16**.

The lightweight construction of the described embodiments provides the functionality of a ladder with added advantages. An operator can maintain two hands for working, with space for supporting tools and materials. The powered lift facilitates operator use and increases operator comfort. The platform provides added safety and maintains the operator center of gravity well inside a tipping line. This structure avoids typical set up and climb up risks of scaffolding.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

The invention claimed is:

1. A mast lift comprising:

a base;

a telescoping mast coupled with the base and extending upward from the base, the telescoping mast including a support section fixed to the base, a middle section displaceable relative to the support section, and an outer section displaceable relative to the support section and the middle section;

a top cap secured to the outer section;

a platform supported by the top cap and the outer section;

a gear box secured to the middle section;

a first gas strut secured at one end to the middle section and acting between the middle section and the outer section and biasing the outer section toward an extended position;

a first threaded driving rod connected between the outer section and the middle section and extending through a first fixed nut assembly;

a second gas strut secured between the gear box and the support section; and

a second threaded driving rod connected between the gear box and the support section and extending through a second fixed nut assembly,

wherein the gear box comprises a power transfer belt connected between the first threaded driving rod and the second threaded driving rod, and wherein rotary power applied to the first threaded driving rod is transferred to the second threaded driving rod by the power transfer belt according to a path of least resistance.

2. A mast lift according to claim **1**, further comprising a drive link coupled with the first threaded driving rod, the drive link receiving a rotary power source to rotate the first threaded driving rod.

3. A mast lift according to claim **2**, wherein the drive link comprises a socket for receiving a complementary bit of a hand-held power drill.

4. A mast lift according to claim **1**, wherein the first fixed nut assembly comprises a housing and a nut disposed in the housing, wherein the first threaded driving rod is threaded through the nut.

5. A mast lift according to claim **1**, wherein the second threaded driving rod is anchored to the base through the support section.

6. A mast lift comprising:

a base;

a telescoping mast coupled with the base and extending upward from the base, the telescoping mast including a support section fixed to the base, a middle section displaceable relative to the support section, and an outer section displaceable relative to the support section and the middle section;

a top cap secured to the outer section;

a platform supported by the top cap and the outer section;

a gear box secured to the middle section;

a first gas strut secured at one end to the middle section and acting between the middle section and the outer section and biasing the outer section toward an extended position;

a first threaded driving rod connected between the top cap and the middle section and extending through a first fixed nut assembly;

a second gas strut secured between the gear box and the support section; and

a second threaded driving rod connected between the gear box and the base and extending through a second fixed nut assembly,

wherein the first fixed nut assembly and the second fixed nut assembly each comprises a housing and a nut disposed in the housing, wherein the first and second threaded driving rods are threaded through the nuts, respectively.

7. A multi-section mast lift comprising:

a base;

a telescoping mast supported on the base, the telescoping mast including a support section secured to the base, at least one middle section cooperable with the support section and displaceable relative to the support section between a retracted position and an extended position, and an outer section cooperable with a topmost one of the at least one middle section and displaceable relative to the topmost one of the least one middle section between a retracted position and an extended position;

a top cap secured to the outer section;

a platform supported by the top cap and the outer section;

a gear box secured to the at least one middle section; and

a lifting assembly for displacing the outer section and the at least one middle section between the retracted and extended positions, the lifting assembly including a threaded driving rod and a gas strut for each of the outer section and the at least one middle section, wherein the threaded driving rods are driven by rotating a single drive link cooperable with the lifting assembly.

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